THE STINGER: A GEOTECHNICAL SENSING PACKAGE FOR ROBOTIC SCOUTING ON A SMALL PLANETARY ROVER.

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Introduction: Flawless operation of mobility systems, excavation, mining and In Situ Resource Utilization (ISRU) operations, regolith transport, and many other activities critically depend on knowledge of the geotechnical properties of the soil in a given area. For example, knowing the soil strength and its density (and in turn fundamental soil parameters: friction angle and apparent or true cohesion) will drive the design of the wheels and excavation systems, and help to determine anticipated excavation energies, time, and forces. Geotechnical tools can be used to assess in situ soil strength prior to the deployment of larger vehicles or the placement of structures. They could also be used to evaluate the stability of slopes (berms or holes dug for nuclear reactors) as well as to evaluate landing zones after soil/rocket plume interaction, which could leave landed spacecraft unstable. Knowledge of soil physical properties can help interpret surface geologic processes and constrain the origins and formation processes of the soils. Further, geological examination of the near subsurface increases understanding of the formation and history of a planet or moon and, by extension, of the solar system. To meet this need, Honeybee has developed the Stinger as a planetary geotechnical instrument. The system combines an Apollo-based penetrometer approach for measuring bearing strength with a Lunokhod approach for measuring shear strength.

The Stinger system consists of a vertical feed z-stage, a mechanism head, and a probe, and is designed to be mounted to a rover such as the KREX-2 rover developed by the Intelligent Robotics Group (IRG) at NASA Ames Research Center. The probe tip is designed after the cone of a static cone penetrometer to allow continuous bearing strength measurement as it is steadily pushed into the ground. A shear vane is also initially housed inside the cone tip of the probe and can be deployed at any depth of interest up to 50 cm to conduct a shear test. When the shear vane is extended, the cone-vane is then rotated to measure the shear strength of the soil. Multiple shear tests can be conducted at various depths at a single test site. This combination of measurements can then be used to calculate Cone Index, Shear Index, and Friction Index and develop a regolith property profile for a vertical cross-section. Test data collected with a Stinger prototype shows very good correlation with data from stand-alone cone penetrometer and shear vane data in multiple different lunar and Martian simulants.

Avionics have also been developed with the instrument to make it capable of autonomous operation. The entire device is ruggedized to survive to survive lunar temperature extremes and vacuum conditions.